SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

June 1977
NSRP 0003

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Proceedings of the REAPS Technical Symposium

Paper No. 15: Present and Future AUTOKON

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

Report Documentation Page

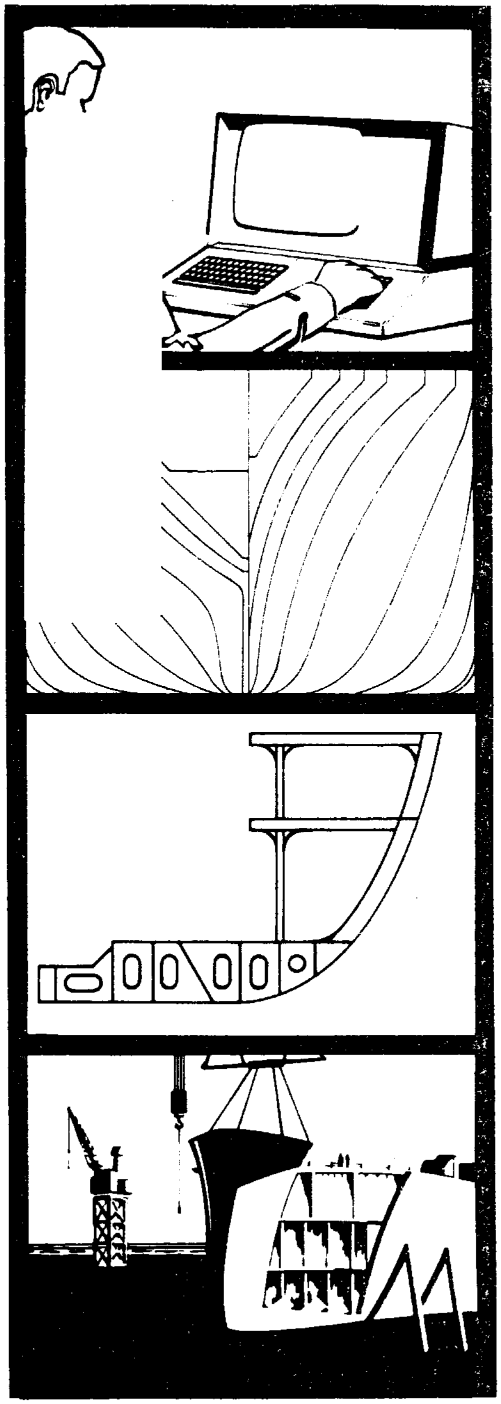
Form Approved
OMB No. 0704-0188

1. REPORT DATE **JUN 1977**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**
4. TITLE AND SUBTITLE **The National Shipbuilding Research Program: Proceedings of the REAPS Technical Symposium Paper No. 15: Present and Future AUTOKON**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192, Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**21**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

DISCLAIMER



R ESEARCH
AND
E NGINEERING
FOR
A UTOMATION
AND
P RODUCTIVITY
IN
S HIPBUILDING

Proceedings of the REAPS Technical Symposium

June 21-22, 1977

New Orleans, Louisiana

PRESENT AND FUTURE AUTOKON

Jan F. Mack
Aker Engineering A/S
Oslo, Norway

Currently, Mr. Mack is Project Leader at Aker Engineering for Interactive Steel Design, a joint project with Shipping Research Services and the Central Institute for Industrial Research. His responsibilities include the user interface with the system and logical database design. He has spent about two years in the development of the AUTOKON/ALKON norm system for ships and semisubmersibles.

Mr. Mack has a B.Sc. degree in Naval Architecture from the University of Newcastle upon Tyne, England.

1. INTRODUCTION

The total design and production of a new product is particularly a problem for large projects, for example special purpose ships and offshore structures, where a close co-operation and control is demanded by owners, classification societies and officials in general.

In today's situation, lacking as it is in new orders, the builder is often forced by the terms of the contract to spend only a very short period of time on design activities. Shortening the leadtime for design and work preparation is as very important for the ability of a company to compete. Preferably this shortening of lead-time must not induce extra costs or be at the expense of prduct quality.

Based on our experiences in the use of EDP as well as our plans for further development,we will focus on what has been done and what may still be done to strengthen our competitiveness in this area.

2. HISTORY

The Aker Group was a pioneer in the practical use of numerical control systems in production, and the use of EDP for efficiently producing information for numerical control.

At the end of the 50s the Central Institute for Industrial Research (CIIR) developed a numerical control unit for oxygencutters and drawingmachines. This control system was called ESSI and was connected to an optically directed oxygencutter at Stord Yard.

In 1961 this system was used for production tasks in the yard. In the first period the individual plates were coded manually on to papertape. At a very early stage Kongsberg started producing this control unit, and has since delivered units for drawingmachines to a large number of companies within shipbuilding, aircraft industry, car industry, textiles, electronics and cartography.

To obtain an efficient numerical description of complicated geometry and subsequent generation of papertape, CIIR, SRS*and AG started a co-operation in 1961 (later called the SIAG co-operation). The purpose was to develop an EDP system. This system, evently named Autokon, was used in production as early as 1963. Thus the Aker Group was the first company in the world to use such a system for production of ships.

This system has later been expanded. and improved. In 1976 it consisted of a suit of batch application programs for a variety of products covering different aspects from early design through production.

Approx. 50-60 yards in Europe and the US are using the system today.

3. AUTOKON 76

AUTOKON has automated some of the previous time consuming jobs like hull fairing and shell plate development. But apart from generating information, AUTOKON provides tools for storage and retrieval of information and possibilities for manipulation of information for a variety of purposes. AUTOKON enables the user to describe in great detail the entire steel structure of a vessel or structure in the database, and to extract a variety of design and production data.

* Shipping Research Services

It is in other words a "drawing generator", but also produces N/C-information, material lists, weight calculations etc.

The main functions of AUTOKON are:

- Formulation of design, drawing and production procedures.

- Structuring of data which are added to the system. Taking care of necessary identification systems.

- Definition of plane geometry.

- Fairing of curves.

- Expansion and verification of complicated geometry.

- Detailing of complicated structures.

- Standardisation of structure elements.

- Material specifications as input to programs for material ordering.

- Control of automatic drawing equipment.

- Numerical control of production equipment like automatic cutting machines, bending machines etc.

- Supplying of data for mounting and assembling such as measurements, weights, centers of gravity, production time etc.

The way of building up master geometry and structural information in AUTOKON is very analogous to the "manual way". First the basic "external" surfaces like shell and upper deck are defined, thereafter in sequence the "internal" basic surface such a longitudinal and transverse bulkheads, tank tops and tween decks, transverse and longitudinal web frames and stringers, etc. See fig. 1.

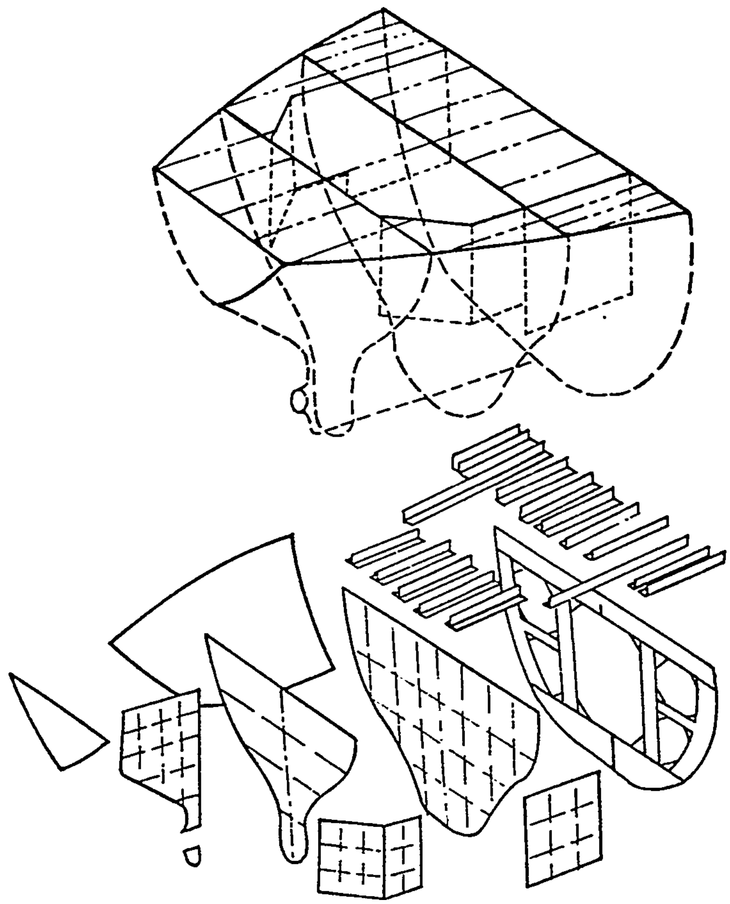


Fig. 1 : Design surfaces and details.

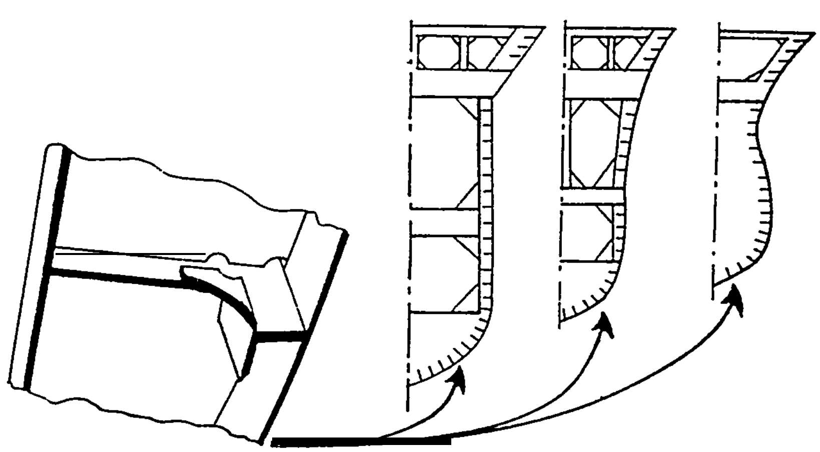


Fig. 2 : Repetitive local stiffening.

On these various basic surfaces the main stiffening is defined, thereafter, the local stiffening. It is not a question of defining piece by piece all information, say 100 local stiffeners on a web frame with a bracket connection to the longitudinal frame, see fig. 2. By means of norms, all stiffener information is generated by a short statement. This statement gives the name(s) of the standard details as well as the environment, for example a set of longitudinals and a web frame. The resulting definition includes the actual shape of the brackets which may all be different due to changes in the angle of run of the longitudinal. The same technique applies to adding cut-outs and holes.

If there is a series of adjacent web frames of similar type, but with different hull form contours, another norm statement will cause the stiffener norm to include all these webframes (fig. 2).

The effect of using this data technology is to reduce the man-hours as much as possible throughout the design and production process, and at the same time improve the consistency of information. Other consequences of using the system are:

- Greater accuracy in design and production.

- Less possibility for errors.

- Reduced routine work.

- Important detailed information available early in the design process.

- More accurate specifications for material ordering.

- Much better control and communication of data between different but mutually dependent departments and yards. (The computer terminals communications with a common data base).

.1 The norms

The basis of the present system of norms rests with ALKON, a problem oriented computer language. It is necessary to know some of the basic properties of this language in order to understand the norm system:

- It maintains a dialogue with the AUTOKON database.

- It has very extensive features for describing geometry.

- It is general in nature and may be used to store various types of information on the database.

  Various data structures may be defined by the user.

- An ALKON manuscript may be stored temporarily (REP) **or** permanently (NORM) on the database.

The last mentioned property is the key feature which enables advanced commands to be built up in the ALKON language. Commands are called NORMS.

It is noteworthy that the simplicity of ALKON and the norms enables the engineers to design and implement systems dealing with problems like:

- Structuring of data.

  Definitions of macros at various levels including also the library of standard details.

  Doing general data manipulation, particularly the various output functions.

This system of norms has been built according to a modular and hierarchical pattern, and range for example from the description of single cutouts to description of the steel structure of the entire double bottom of a ship including tanktop, floorplates etc. (fig. 3).

Central in this context is the above mentioned library of standard details which includes brackets, cutouts and holes, all of which are coded as ALKON norms. The various output-norms generate papertape for drawing and cutting of plates, and give relevant data for material ordering, weldlengths, centers of gravity etc.

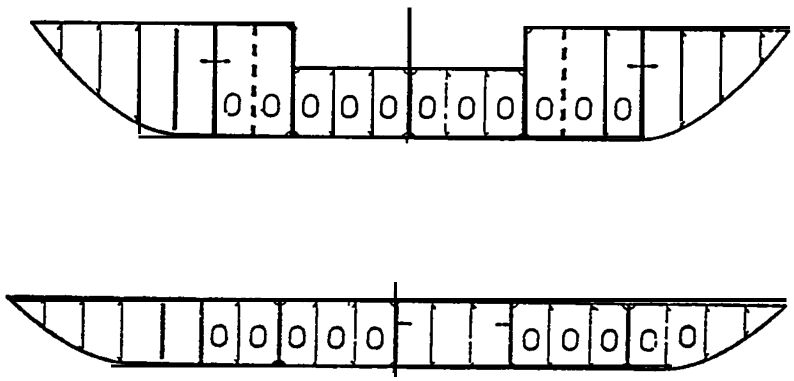


Fig. 3 : Floors

As concerns ships, an extensive system of norms is available. The normsystem is also quite flexible. An example of this is how the Aker Verdal Yard managed to increase efficiency for some activities in Jackets design. Based on AUTOKON norms, ten activities were coded. (Fig. 4).

After a few weeks the first norms were actually used in production preparation. The norm which generates the template for the cutting of truss connections (activity 8) produces a template demanding a total manhour of 20 to 30 minutes. Manually a good craftsman would manage 2 to 3 templates a day.

The accuracy obtained using a numerical method was far better and a substantial saving and better product quality was registered. Let us just mention that in 12 leg Jacket which has been built there were 560 such templates. The tubes in the Jacket had a diameter of up to 1.5 meters and a platethickness of up to 70 millimeters. The actual truss-connections may be very complex often with tubes intersecting eccentrically.

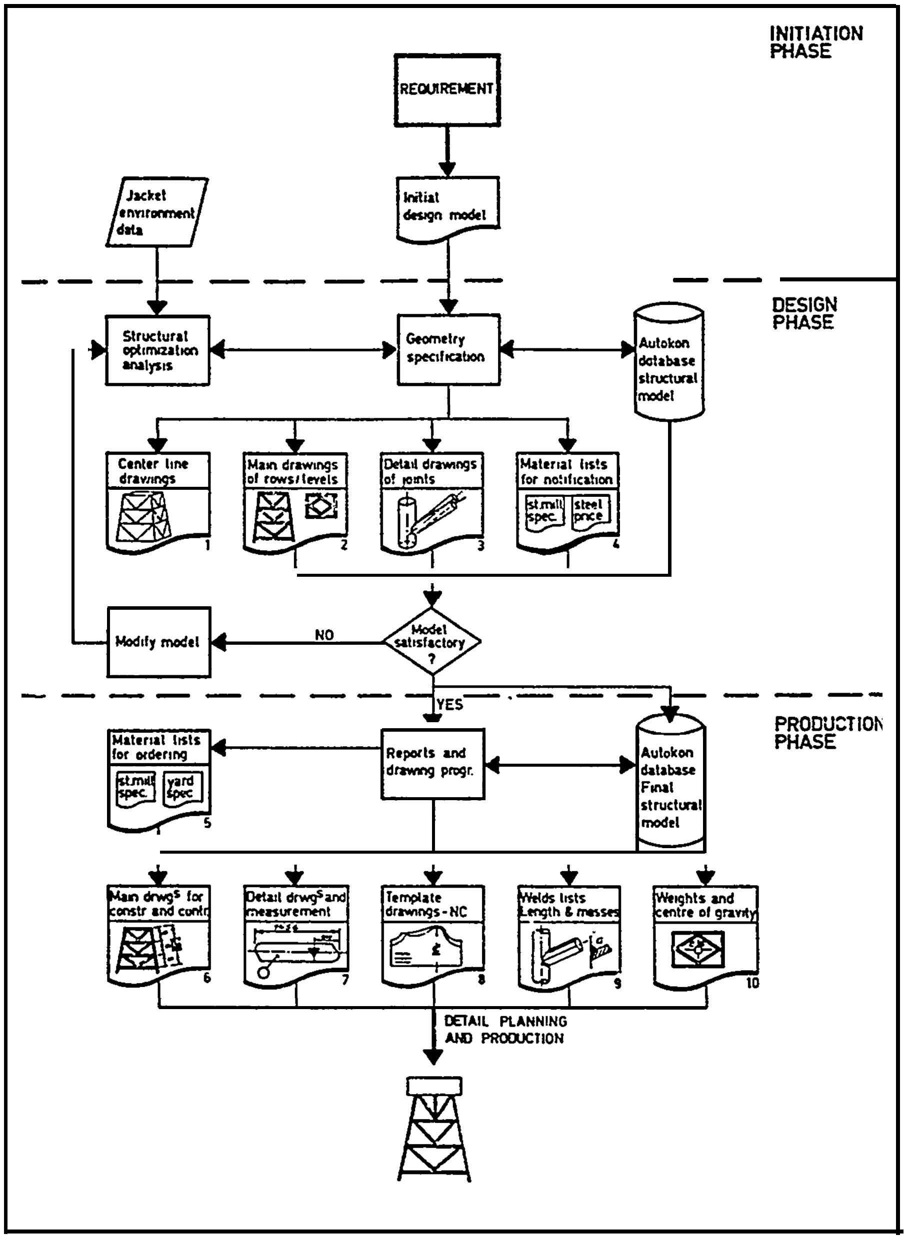


Fig. 4 : Jacket design

4. CURRENT DEVELOPMENT

There are currently two major development projects going on in SIAG:

- AUTOFIT which aims at the outfitting aspects of design and production of ships and offshore structures (not treated here).

- Interactive AUTOKON (IA) which aims at the design and manufacture of large steel constructs (ships' drilling /production platforms and other offshore structures).

IA includes a wide variety of applications, some of these presently covered by the AUTOKON system. We look at this new development with the intent of producing a technical information system. The crux of this system is the product model which conveys information to various analysis programs, other information systems or directly to the users (see fig.5).

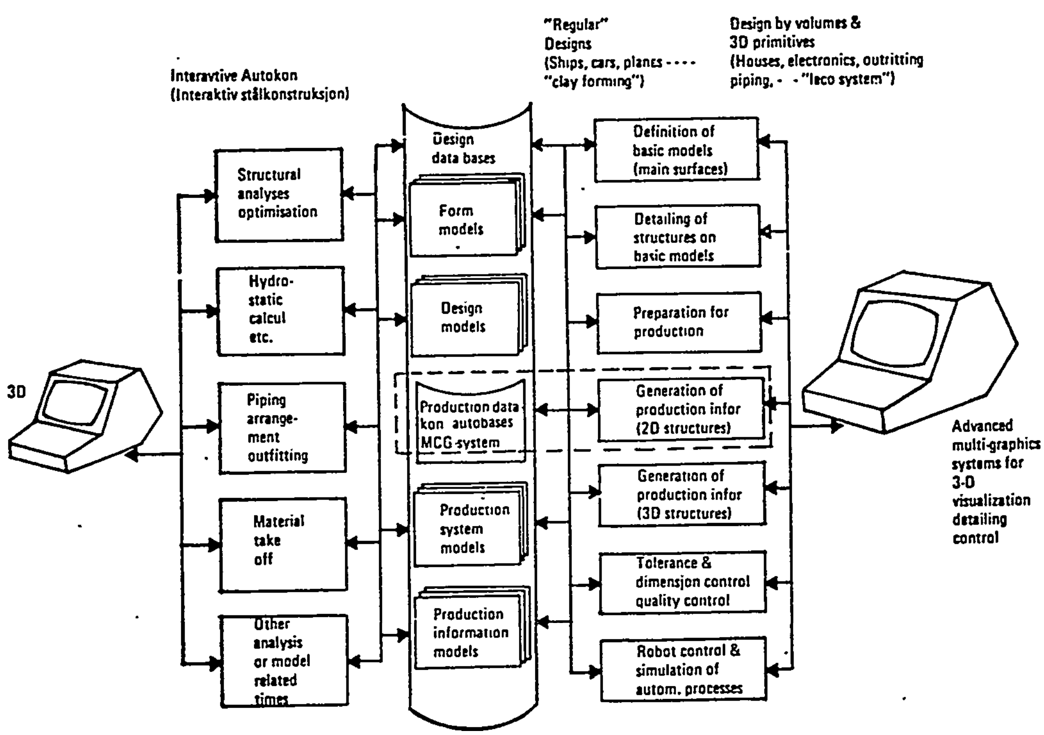


Fig. 5 : Interactive AUTOKON

UPresently (1977) the effort is directed at;

a) Design of the product model. The subsequent sections will discuss two aspects of this product model:

   1) Its ability to handle the iterations in the design process (changes).

   2) The interface with the human user.

b) Design and implementation of the first application programs.

The experience in ship design is that more than 50% of the manhours is spent on preparation for production. This includes the generation of shop drawings, definition of parts to be tooled etc. These key applications are therefore given high priority.

The applications include:

- An interactive part coding system

- A general purpose drafting tool.

- An interactive nesting system.

- A system for material specification.

The nesting system is presently (1977) used in production, temporarily using information provided by AUTOKON.

4.1 Limitations of Batch Systems

Today we produce a fairly complete basis for production using our batch systems. This information is produced spending less manhours than by manual methods. The results are also significantly better.

It is quite clear, however, that we have now reached a practical limit as concerns flowtime using such systems.

This is partly due to the wide variety of products which does not allow standard norms at a very high level.

Also our ambitions as concerns the scope of our information system has increased. We now want to include a large portion of the information flow in design and work preparation. In the following some of the objectives of our new system are discussed.

4.2 Availability of Information

We distinguish between three categories of information users. These impose different demands on format and presentation of information.

1. The draftsman or designer. His demands as regards communication with the system are particularly difficult to satisfy. This aspect is discussed in a later section.

2. Analysis program/systems. The trouble with these are their different requirements for data representation. We have no intention of making large scale changes to the analysis programs. Yet the information system must provide the relevant source data, geometry, topology and other information for these programs. (Our solution to this incorporates procedure models, reference 4).

3. Other information systems. Such systems are in operation today in fields like material administration and piping/ outfitting. There is need for a varying degree of intergration and interaction between such systems. Although these will still have separate data bases we intend to make them satellites in the same information environment.

4.3 Common Source for Information

The system will act as a communication device in the widest sense.

Information coming from one department will be immediately available in other departments. Different but mutually dependent tasks are thus linked closer together. Repetitive build up of the same information for different tasks is avoided.

4.4 Information Consistency

This is a major problem in manual information systems. Interdependent information is built up in different locations which in itself is a source for errors and inconsistencies. Changes typical to any design process add to the problem. In real life, drawings coming from only one department or even one draftsman are often inconsistent. In our automatic information system we aim at using the same source model for a large number of different tasks. Updates added to this central model will thus be immediately reported and available.

Furthermore, improved internal consistency is implicit in the structure of the model.

- The model produces 3D as opposed to 2D drawings.

- Topological description takes care of the relationships (connectivity) in the model. This also ensures that the consequences of changes are automatically taken into account. See next section.

4.7 The Change Oriented Product Model

A particular design is never really finished even if at some time there is a decision to build it. The process of design consists of a series of iterations aiming at some ideal product. In the batch systems the inability to respond to changes is a severe limitation which influences the lead time.

A particular problem is the influence of one change on other parts of the structure. A small change in the hull shape may effect hundreds of details as concerns shape and position. The number of adjustments to the geometry of structural details is error prone and very time consuming if done manually. How shall we deal with this? The effect we wish to obtain is perhaps best illustrated by the following.

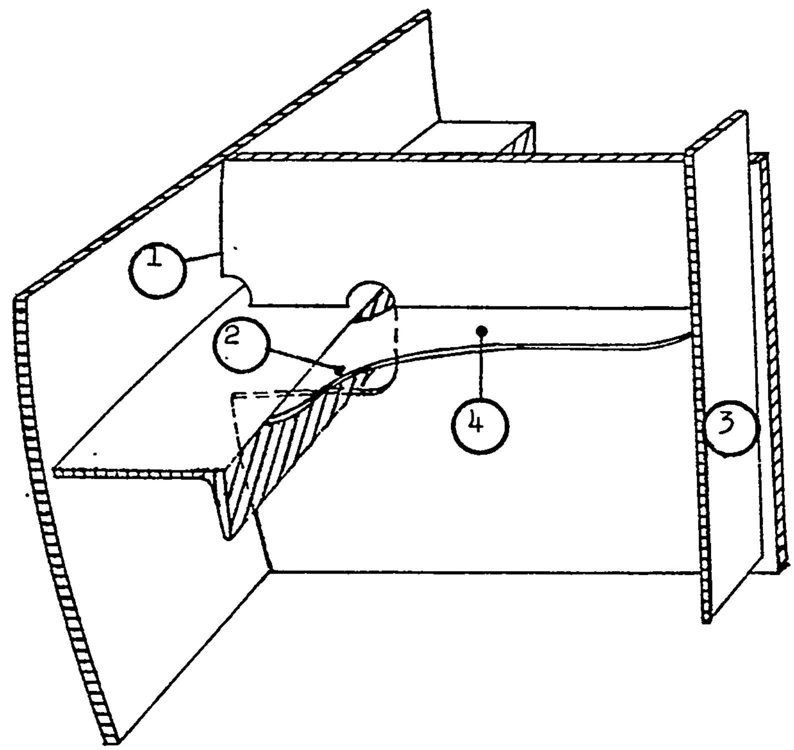


Fig. 6 : Structural dependence between surfaces and details.

In fig. 6 we have for example started off with a description of the shape of a ship hull. This hull may be defined in a variety of ways, but for the sake of argument the representation may be a set of transverse frames (1) . The important point is that the longitudinal frame (2) and the flange of the web frame (3) are defined relative to the hull description. This means that primarily the data base contains a description of how (2) and (3) are derived from the hull description (1) for example by a reference to a parallell routine and the relevant parameters (parallell distance).

Furthermore, the bracket (4) is again defined relative to (2) and (3) Note that even if the geometry of (1) has not yet been described, the other feature may.

The purpose of the product model is to describe the product by identifying its functional entities and their relationships or "connection structures". These connection structures we call the topology of the product The topological description is separate from, but may refer to the geometrical description of primitives. In cases of geometrical changes the topological description refers to sufficient information to generate the new geometrical solution. This approach has the following advantages:

- Only a minimum of geometrical data is needed to describe the structure (minimum of data redundancy). Thus it means less work in the initial definition of the product.

- The descriptions of topology and geometry are separate and independent of each other which means that for a ship the internal structure may be defined prior to having defined the hull shape. More generally this allows flexibility as concerns the work sequence in a typical engineering design process (fig.7).

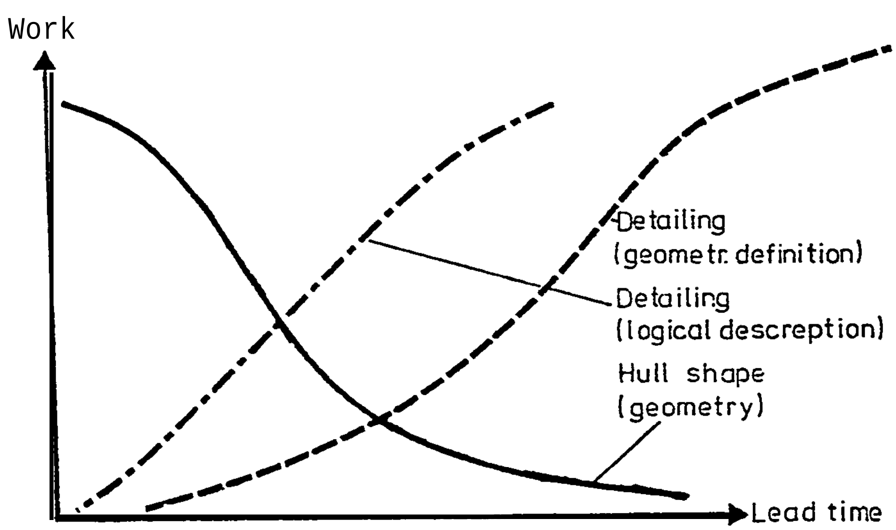


Fig 7 : Reduction in lead time.

All the geometric consequences of a change in scantling "(the most typical change) will inherently be taken care of without additional changes to the data base. The ability to handle changes and updates is certainly a major problem area. The topological description should reduce this problem to a minimum giving a change oriented system.

- Additional or alternative geometric representations are easily introduced. This is due to the fact that the major part of the product description is geometry independent and therefore does not change.

4.6 User Communication

The dialogue between the designer and the system is the key to user acceptance. This represents the face of the system and a major usability factor.

It is a problem which concerns hardware as well as software. The basic reason for the concern with this problem is on one hand the amount of information needed to describe our type of product in detail and on the other the amount of verification necessary. The number of structural details (pieces) in a large tanker is on the order of 100,000. The solution is partly found in the use of interactive and graphical methods.

In hardware terms this implies the use of mini computers and display screens.

Some points will illustrate the advantages to the designer who operates the system :

The work procedure is simple. There is a direct dialogue which eliminates the traditional punching forms, card decks, input, waiting etc.

The communication language is simple.

- Sketches and drawings as well as visual symbols are natural means of communication for engineers and draftsmen. (Our draftsmen are definitely reluctant to accept systems which require large amounts cryptic codes).

- There is a pronounced need for continuous verification of results (1 - 2 hours is often too long to wait for an error message which turns out to be trivial).

- The draftsman often needs the ability to make decisions based on intermediate results.

These points promise greater efficiency, but will also shift the emphasis from the handling of the system itself to more creative aspects of design - a more satisfactory work situation.

ACKNOWLEDGEMENT

We are indebted to F Lillehagen and J. Øian of the Central Institute for Industrial Research and P. Sørensen, S.A. Hansen and F.v. Cuilenborg of Shipping Research Services, all of whom have contributed to the projects and this paper.

REFERENCES

1. IPC Science and Technology Press Limited, CAD 76, "proceedings from Second International Conference on Computers in Engineering and Building Design", Imperial College, London, 23/25, March 1976.

2. IIT Research Institute, "Proceedings of the REAPS Technical Symposium", Atlanta, Georgia, June 1976.

3. Sørensen, P.F.: "Production Methods in the Aker Group", Offshore Symposium, Moscow, Oct. 1974.

4 J.J. Allan III, "CAD Systems", Proceedings of the IFIP Working Conference on CAD Systems, Austin, Texas, Feb. 1976.

Additional copies of this report can be obtained from the National Shipbuilding Research and Documentation Center:

http://www.nsnet.com/docctr/

Documentation Center
The University of Michigan
Transportation Research Institute
Marine Systems Division
2901 Baxter Road
Ann Arbor, MI 48109-2150

Phone: 734-763-2465
Fax: 734-763-4862
E-mail: Doc.Center@umich.edu